ROCKY FLATS PLANT, PLUTONIUM
MANUFACTURING FACILITY
(Building 707)
North-central section of Plant, just south of bldg. 776/777
Golden vicinity
Jefferson County
Colorado

HAER No. CO-83-M

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
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ROCKY FLATS PLANT,
PLUTONIUM MANUFACTURING
FACILITY
(Rocky Flats Plant, Building 707)

HAER No. CO-83-M

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 707 is located in the central section of the protected area of the Rocky Flats Plant (Plant).

Date of Construction: 1970.

Fabricator: C.F. Braun and Company, Alhambra, California.

Present Owner: United States Department of Energy (USDOE).

Present Use: Plutonium Weapons Components Manufacturing.

Significance: This building is a primary contributor to the Rocky Flats Plant historic district associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 707 was the primary plutonium manufacturing and assembly facility at the Plant from 1970 until curtailment of operations in 1989. The design of Building 707 incorporated extensive control and safety features, including the first-time use of inert atmosphere in the glove boxes, primarily in response to two earlier fires (in Buildings 771 and 776/777). The building was originally intended to house new fabrication processes associated with new plutonium weapons designs, but many of the existing foundry and fabrication operations from Building 776/777 were transferred to Building 707 as the result of a 1969 fire in Building 776/777.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These

goals and objectives have not been finalized, but include waste cleanup and demolition. Recommendations regarding National Register of Historic Places eligibility were developed to allow USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence, and to provide for management of historic properties at the Plant.
From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was officially listed in the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads called theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focuses on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations; research and development; health and safety of workers; and security.

Chronology of Building 707:

1967 Construction of Building 707 began.

1970 The first plutonium operations in Building 707 began on May 25. Operations focused on casting and fabrication of plutonium components and final assembly of the plutonium triggers.

1971 The Building 707 Annex (Building 707A) was constructed.

1972 The X-Y retriever used for handling and storing plutonium began operations in the spring.

1989 Operations including metallurgy, fabrication, assembly, inspection, and testing of plutonium and plutonium parts ceased in November following a Federal Bureau of Investigation raid on the Plant.

1992 Operations included removal of oxides from plutonium metal and repackaging the cleaned metal; storage of removed oxides began under the new Plant mission of environmental restoration.

Building History:

Building 707 became the primary plutonium fabrication building at the Plant when operations commenced on May 25, 1970. The design of Building 707 incorporated extensive control and safety features, including the first-time use of inert atmosphere in the glove boxes, primarily in response to two earlier fires (in Buildings 771 and 776/777). The building was originally intended to house new fabrication processes associated with new plutonium weapons designs, but many of the existing foundry and fabrication operations from Building 776/777 were transferred to Building 707 as the result of a 1969 fire in Building 776/777. The transferred operations were not changed significantly. Building 707A was built in 1971 to accommodate plutonium casting and fabrication processes moved from Building 776/777 as a result of the 1969 fire.

Building Description:

The Building 707 complex was a manufacturing facility for fabrication of plutonium parts, and assembly of parts made of plutonium and other materials into nuclear weapons components. The major structures of the complex include Building 707, Building 707 Annex (707A), and Building 708. Building 708 houses emergency generators and three brine chiller systems for Building 707 temperature control and dehumidification in plutonium handling areas. Other structures in the complex are a cooling tower, an electrical distribution station, a process waste station, and outside storage tanks for inert gases, such as argon and nitrogen.

Building 707 is located in the north-central section of the Plant, within the protected area and just south of Building 776/777. Building 707 is a two-story building with a single-story section on the east side. The two-story portion is 160' x 464'. The single-story section is 40' x 464'. The two-story portion of the building is 74,240 square feet per floor while the single-story section is 18,560 square feet. A small basement in Building 707 contains an additional 1,000 square feet.

Building 707 has precast, prestressed concrete exterior walls, supported on precast concrete columns. The first floor is a concrete slab on grade. All floors in the production areas are reinforced concrete finished with an epoxy coating designed to facilitate decontamination. The roof is constructed of prestressed, precast concrete twin-tee panels. There are no windows in the exterior walls.

The single-story portion of Building 707 contains office and support areas, and is divided into three main sections. The northern section consists of offices, a conference room, a data processing equipment room, restrooms, janitor closets, and an entrance lobby, all opening into a corridor. An airlock separates non-plutonium handling areas from plutonium production areas. The middle portion of the single-story section was used for radiographic inspection. The radiography area consists of two vaults housing radiographic inspection equipment and an adjoining support area. The southern section of the single-story section houses a shipping and receiving area. This area contains production storage, offices, shipping and receiving space, a waste drum counting and storage area, a maintenance area, and two docks with airlocks opening to a recessed loading area under the single-story roof.

Building 707A, a freestanding two-story structure, is 104' x 125' and abuts the northwest side of Building 707. It contains 13,000 square feet per floor. Although Building 707A is a separate structure, with its own east wall, it is considered to be part of Building 707. Operations within the two buildings were integrated.

Building 707/707A is divided into ten modules, which are separate rooms, sets of rooms, or workstations, segregated from other non-plutonium production areas. Letters A-K are used to designate the modules. There is no Module I.

The main floor of Building 707 is compartmentalized into eight side-by-side modules (A through H) which contained one or more of the primary production operations. Each module is 140' x 49' with an area of approximately 6,860 square feet. Modules A though E were identical in size and shape, but contained various glove box configurations designed to support the specific operation performed in each module. The main floor of Building 707A is divided into two modules, Modules J and K, which contained plutonium foundry operations and two plutonium storage vaults. One storage vault, on the north end of Module K, was equipped with a remotely controlled, computerized, three-axis retriever (the X-Y retriever). The basement room (under Module C) was used for filtering and storing machining coolants and other process liquids.

Inert atmospheres were provided for the glove boxes and conveyors of Modules A, B, C, D, E, F, J, and K to prevent the propagation of fire. An enclosed chain conveyor connected glove box workstations in and between the modules. Leaded gloves were affixed to ports in the equipment to allow operator access. Temperature and humidity controlled air was provided to other plutonium handling areas.

Module F is divided into two areas, one for special assembly operations which required specialized atmospheric controls, the other for final processing. The temperature, humidity, and airflow in Module F were precisely controlled. The module has airlocks for equipment and personnel, alarms, an escape door, and a tall equipment door. Downdraft tables are equipped with a mesh screen work surface and high-efficiency particulate air filters to draw air in the room toward the table, through the filter, and out through the exhaust ventilation plenum. A conveyor line connects one of the downdraft tables to Module E.

Module G is divided into separate areas for offices, sub-assembly processes for non-radioactive areas, inspection, and two laboratories (standards and non-destructive testing).

Module H contains six high-pressure process chambers, an open process area, and a storage vault. The storage vault is freestanding, and does not form a part of the main building structure. The vault is constructed of concrete to provide additional radiation shielding.

The second floor of Building 707 contains heating, ventilating and air conditioning equipment, and air filtration systems. Some equipment, tanks, and pumps are also located on the second floor. Utility equipment located on the second floor provides air filtration, ventilation, and dehumidification to the modules and glove boxes. Two inert atmosphere systems maintain a dry, inert atmosphere of nitrogen, with less than five percent oxygen. Each system includes a separate exhaust plenum equipped with a four-stage, high-efficiency particulate air filter. A standby filter is connected to the two plenums to allow high-efficiency particulate air filters in either system to be changed without interruption of service. The arrangement of the northern end of the two-story portion of Building 707 is duplicated in Building 707A. Two production modules, J and K, divide the first floor, and heating, ventilating and air conditioning equipment is located on the second floor.

Building Operations:

Operations in Building 707 included metallurgy, parts fabrication, inspection and testing, assembly, and storage. Plutonium, particularly in finely divided forms, was subject to oxidation and spontaneous combustion, and required a controlled environment for processing and storage. Control was achieved by enclosing plutonium metal and associated equipment within glove boxes and conveyors and by providing certain work areas with an inert atmosphere to control the pyrophoric nature of plutonium. The general flow of work and materials was from north to south within the building, starting with Modules A, J, and K, then sequentially from Module B to Module H.

Modules A, J, and K
Modules A, J, and K were used for metallurgy, primarily casting and sampling of plutonium metal. These modules contained casting furnaces, glove boxes, and casting molds made of graphite and other metals. Operations were conducted in an inert atmosphere. The primary difference between casting operations in Modules K and J were the types of molds used: graphite molds were used in Module J, and molds made of other metals were used in Module K. Ingots were sampled by breaking a small nodule off the side of the casting. Limited casting operations were conducted in Module A. Other activities in this module included sampling of cast ingots for analysis of chemical purity, and removal of plutonium oxides and other impurities from the casting molds.

The casting process created feed ingots and War Reserve ingots of plutonium metal. Materials used for the creation of feed ingots included plutonium buttons from recovery processes, briquettes, and scrap plutonium metal. The first casting process created the feed ingot, which was then sampled. The sample was transferred to Building 559 and analyzed for chemical composition and purity. Production control personnel maintained all records of ingot composition, and used this data to calculate the precise feed ingot mixture which would produce a War Reserve ingot of specific purity. The second casting process used this feed ingot recipe to create the War Reserve ingot. The War Reserve ingot was used to fabricate weapons components, the purity of which was identified by design specifications. Samples were taken to verify the chemical makeup of the War Reserve ingot as well.

The casting process, conducted in a vacuum, consisted of weighing the metal, placing it in tantalum crucibles, and melting it in one of four electric induction furnaces. Molten metal was poured into graphite, tantalum, or erbium oxide-coated stainless steel molds to form ingots. Although four furnaces were present in Module K, only two were used during routine casting operations. Rejected ingots from casting in Modules A, J, and K were cut with a shear press within a glove box and returned to the X-Y retriever for storage.

Module B
Plutonium War Reserve ingots cast in Modules A, J, and K were rolled, formed, and heat-treated in Module B under an inert atmosphere. War Reserve ingots were rolled to a specified thickness then moved to another glove box where shapes were cut in a blanking press. Cut blanks were sent to adjacent glove boxes for thermal treatment (annealing and homogenizing). Following thermal treatment, blanks were formed into hemi-shells (1/2 shells) in a hydroform press. After forming, the parts were annealed and measured on a density balance. A percentage of the parts were selected for further quality assurance evaluation. Scraps left from cutting were cut into smaller pieces in the same glove box, placed in a container, and sent to the briquetting process in Module C.

Module C

Activities in Module C were conducted in an inert atmosphere. The module was used for final machining of plutonium parts and also contained equipment for the briquetting process. Glove boxes within Module C contained lathes, mills, a drill box, a high-precision drill press, cleaning solvents, and a hydraulic press. Machining operations included jig boring, slot cutting, and threading. All tools, gauges, and fixtures remained within the glove boxes for the useful life of the device and were removed only for disposal. When machining operations were completed, the parts were cleaned, degreased, and stored to await assembly.

The briquetting process was used to generate hockey-puck-sized briquettes of plutonium metal scrap. Machine turnings and scrap from the blanking press were cleaned in a solvent bath to remove cutting oils, then pressed into small briquettes. These briquettes were returned to the foundries for casting of feed ingots.

Module D

In Module D, each machined part was marked with a serial number, cleaned, weighed, and inspected. As part of the cleaning process, parts were also repeatedly wire brushed to remove oxides. Completed parts were transferred to Module E by a chain conveyor.

Module E

In Module E, plutonium parts were welded with electron beam welders in glove boxes, then inspected for leaks using non-destructive testing methods. These methods included radiography x-ray examination of plutonium parts to identify structural flaws; eddy current testing on plutonium parts to check the depth of weld penetration; and weld scanners and fluorescent dye penetrant processes to qualify welds and detect minute cracks and voids in parts. The washing, welding, and leak detection processes in Modules D and E were repeated several times.

Module F

Module F contained an assembly area referred to as the super-dry room, where plutonium parts were assembled and tested. The super-dry room provided space for special assembly operations that required precisely controlled conditions of humidity, temperature, and airflow. As part of the assembly process, an outer metal casing was welded onto the plutonium components. One area of the super-dry room was divided into two compartments, each was provided with a downdraft table. One of the downdraft tables opened into the end of a conveyor line that crossed over Module E. At this downdraft table, uncoated plutonium parts and other parts from previous glove box operations were assembled into units that could be safely transported, processed, and stored outside the protection of a glove box.

Leak testing was conducted on stainless steel and beryllium parts. Each part was placed on one of ten pump-down tables and a vacuum was exerted on the part to check for leaks and to remove moisture. The encased parts were then transferred to Module G for further processing.

Module G
Activities in Module G included brazing, machining, non-destructive testing, and non-plutonium parts assembly and disassembly. Plutonium parts encased in other metals were brazed under a vacuum. The machining process used two lathes inside B-boxes (similar to lab hoods) and a milling machine. Subassembly of non-radioactive parts occurred in a portion of the module. Rejected aluminum, stainless steel, and beryllium parts were also disassembled in Module G and either recycled or processed for disposal. Glove boxes were not used in this Module.

Module H
Assembly processes in Module H included brazing and high-pressure assembly whereby parts comprised of various metals including beryllium, plutonium, and uranium were bonded together under pressure. Final assemblies were transferred to Building 991 for eventual off-site shipment.

Testing and Inspection
Individual parts, subassemblies, and assemblies were inspected and tested throughout the metallurgical machining and assembling operations to ensure that specifications were met. Inspection involved dimensional inspection (measuring). Testing processes were both non-destructive and destructive. Precision hand and electronic gauges, scales, rings, optical- and computer-assisted instruments, and laser beam instruments were used during dimensional inspections to verify that directly measurable dimensions were within specified tolerances. Parts were matched for physical and dimensional characteristics.

Non-destructive testing was used to inspect interior characteristics or properties of a part or assembly. The techniques most commonly used were radiographic x-ray examination, and ultrasonic, acoustic emission, and eddy current scanning. Other non-destructive measurement methods included weight and density determinations and leak tests. Radiography detected cracks, voids, and gaps in parts and assemblies. These testing techniques identified structural flaws, weld depth, minute cracks, voids, and gaps. Vacuum tests were conducted on plutonium, stainless steel, and beryllium parts to check for leaks and to remove moisture and other impurities.

Destructive testing was used to verify the chemical content and the physical integrity of a part or assembly. Parts and assemblies were subjected to gravity force analyses, and tensile strength, stress, and vibration testing. Parts were also cored and sawed for spectroscopy and chemical analyses.

Assembly
Assembly included such operations as machining, cleaning, matching parts, brazing, welding, heating under vacuum for trace contaminant removal, marking, weighing, monitoring for surface contamination, and packaging for shipment. Inspection and testing processes occurred throughout the assembly process. Parts were matched for physical and dimensional

characteristics, assembled, then welded or brazed into subassemblies. The subassemblies and additional parts were cleaned, physically assembled, welded, machined to the required contour, and marked. The assembled parts were subjected to final processing steps, final testing, and inspection, then stored to await shipment.

Storage

Several locations in Building 707 were used to store nuclear and non-nuclear materials. Materials stored included raw materials needed for casting, feed ingots, War Reserve ingots, parts cast within the building, and finished components.

The X-Y retriever, which began operations in 1971, was housed in Module K, and was used to sort and retrieve plutonium metal for distribution to other processes in Building 707. Using the X-Y retriever, operators retrieved plutonium metal from storage and conveyed it to the X-Y shuttle area where it was cut and weighed. The cut pieces were then conveyed to Modules A, J, or K for casting, or Module B for rolling and forming. Rooms 141 and 142 in Module J (the J vault) were used for storage of oxides, plutonium buttons received from other USDOE facilities, and to some extent, Building 771 molten salt extracts.

Support Operations

Support groups assigned permanently to Building 707 included departments common to all process buildings, such as radiation monitoring, utilities, maintenance, custodial, tool crib, and industrial engineering. Support groups unique to Building 707 included several manufacturing technical support groups, production control, process material control, final product certification, and USDOE inspection. The production engineering support group was responsible for troubleshooting equipment problems, coordinating appropriate repairs, utilizing maintenance and assistance from the research and development group, ensuring compliance with specifications and adherence to production schedules, tracking production programs, and providing input for new production systems. The production foreman was responsible for tracking worker training and new worker indoctrination, and provided input to production engineering regarding production schedules and new production systems.

The metallurgical support group was responsible for administration of plutonium metal used for casting, scrap plutonium metal, and operation of a control system for laboratory analysis data on plutonium metal.

Plutonium Recovery

Plutonium was a rare substance, and supply seldom kept up with demand. Only a fraction of the feed plutonium that entered Modules A, J, or K came out of Module D as machined production parts. Every effort was made to salvage the excess material. Plutonium fines, chips, and scraps generated from the parts fabrication processes were collected in cans at each workstation or individual machine. These fines, never leaving the inert atmosphere system, were transferred via the chain conveyor to a workstation in Module C where the material was compressed into briquettes for later use. Residues produced by the casting operations were burned to oxide, packaged, and transferred to residue processing operations in Building 771 for plutonium recovery. This thermal stabilization process was used to convert pyrophoric plutonium to a non-pyrophoric plutonium oxide, which could be more safely handled.

Operations Since 1989
Following a raid by the Federal Bureau of Investigation in 1989, production at the Plant was curtailed. In 1992, the mission of the Plant was officially changed from weapons component production to environmental restoration and waste management. At that time, the mission of Building 707 was changed to plutonium stabilization operations.

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